California's Energy Future

Scenarios for Economic Growth and Sustainability from the

BEAR

Model of the California Economy

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Objectives

1. Improve visibility for policy makers.
2. Estimate direct and indirect impacts and identify adjustment effects.
3. Promote empirical standards and capacity for policy research and dialogue.

Why use an economic model?

- Most human-induced environmental change originates in economic activity.
- Environmental effects of policy will largely result from economic responses.
- Thus, to understand environmental incidence, we need to understand economic behavior.

Why a state model?

1. California needs research capacity to support its own policies
   - A first-tier world economy
2. California is unique
   - Both economic structure and emissions patterns differ from national averages
3. California stakeholders need more accurate information about the adjustment process
   - National assessment masks extensive interstate spillovers and trade-offs

Why a General Equilibrium Model?

1. *Complexity* - Given the complexity of today's economy, policy makers relying on intuition and rules-of-thumb alone are assuming substantial risks.
2. *Linkage* - Indirect effects of policies often outweigh direct effects.
3. *Political sustainability* - Economic policy may be made from the top down, but political consequences are often felt from the bottom up. These models identify stakes and stakeholders *before* policies are implemented.

Model Structure

The modeling facility consists of two components:

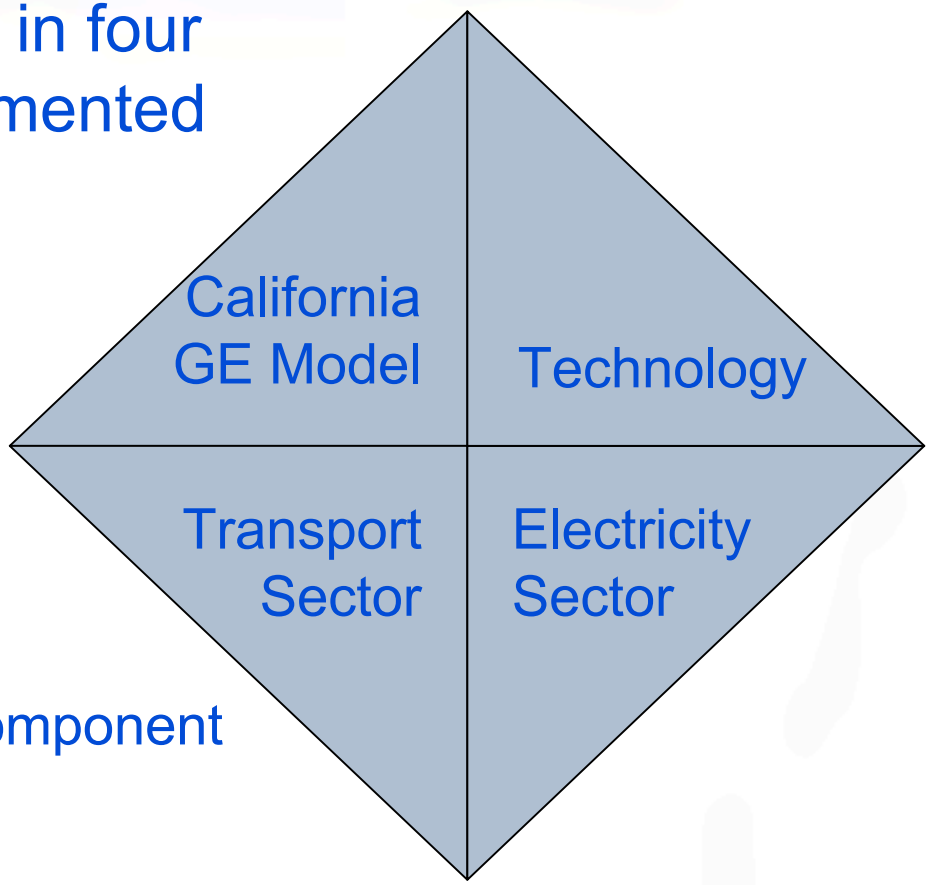
1. Detailed economic and emissions data (2003)
   - 104 sectors
   - 10 household groups (by tax bracket)
   - detailed fiscal accounts
   - 14 emission categories
2. Berkeley Energy And Resource (BEAR) Model – a dynamic GE forecasting model

How we Forecast

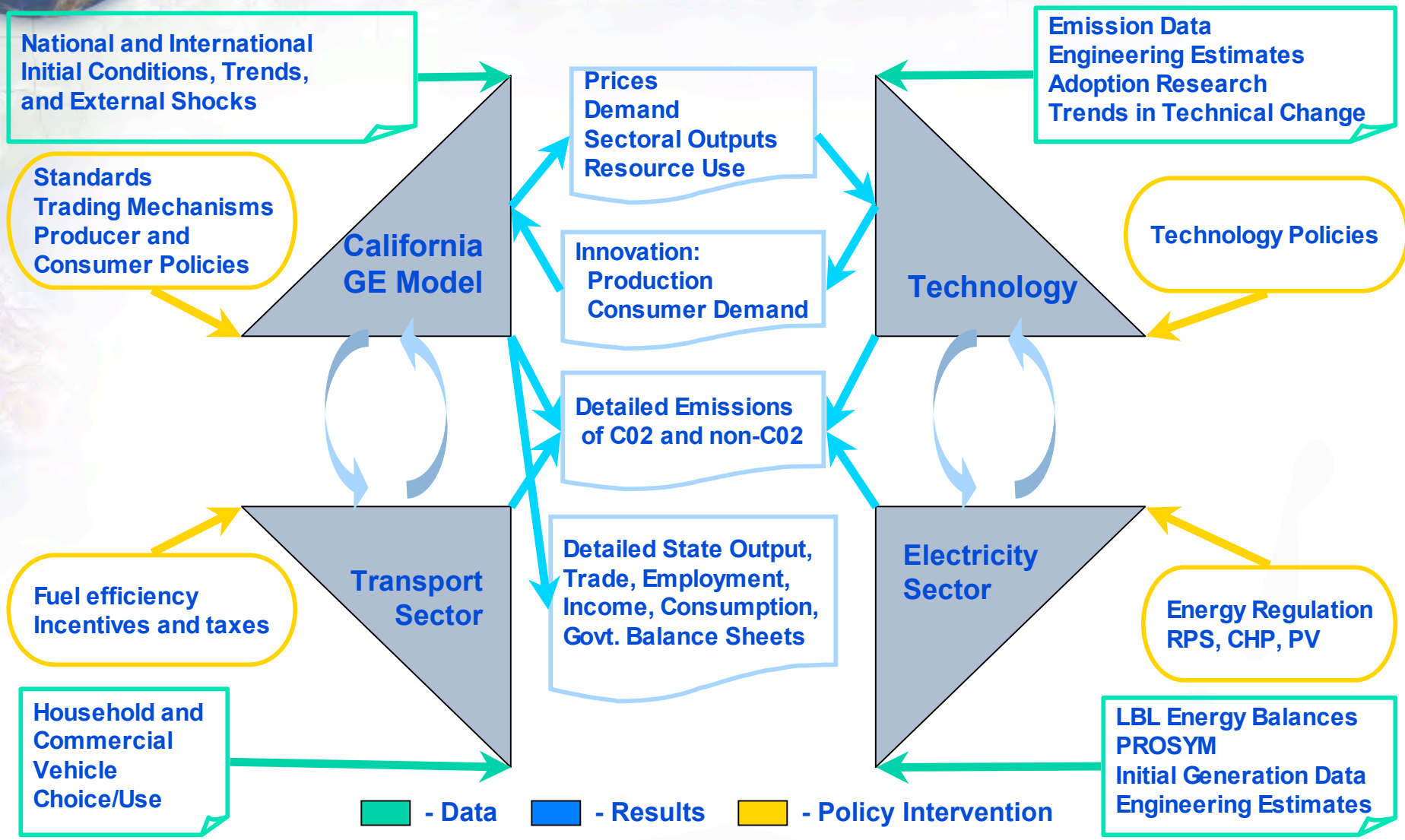
BEAR is being developed in four components and implemented over two time horizons.

Components:

1. Core GE model
2. Technology module
3. Electricity modeling
4. Transportation component



Detailed Methodology



What is a General Equilibrium Model?

- Detailed market and non-market interactions in a consistent empirical framework.
- Linkages between behavior, incentives, and policies reveal detailed demand, supply, and resource use responses to external shocks and policy changes.

Modeling Technological Change

Extrapolating today's energy and emission characteristics is far too pessimistic.

Efficiency incentives and scarcity drive continuous innovation, including:

- Exogenous and Endogenous Innovation
- Induced Technological Change
- Learning-by-Doing

Electricity Sector Modeling

Power generation accounts for 25% of C02 emissions within California.

Based on detailed producer data from CEC/PIER/PROSYM, we model technology and emissions in California's electricity sector

- Eight generation technologies
- Eleven fuels

Transportation Modeling

- The transport sector accounts for up to 48% of California C02 emissions
- To meet our emission goals, patterns of vehicle use and technology adoption need to be better understood:
- You can contribute to this effort:

www.carchoice.org

Time Horizons

BEAR is being developed for scenario analysis over two time horizons:

1. **Policy horizon**: 2005-2025

   Detailed structural change:

   1. 50 sectors
   2. 10 household income groups
   3. Labor by occupation and capital by vintage

2. **Climate horizon**: 2005-2100

   Aggregated:

   1. 5 sectors
   2. 3 income groups
   3. labor and capital

Economy-Environment Linkage

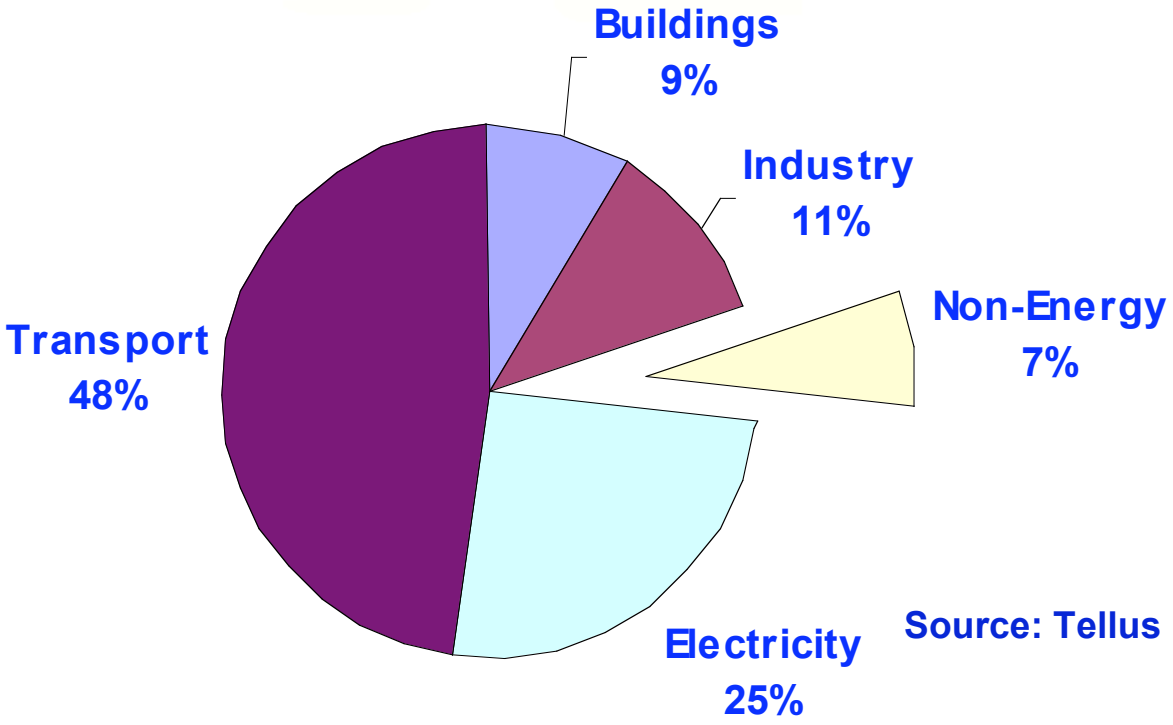
Economic activity affects pollution in three ways:

1. *Growth* – aggregate growth increases resource use
2. *Composition* – changing sectoral composition of economic activity can change aggregate pollution intensity
3. *Technology* – any activity can change its pollution intensity with technological change

All three components interact to determine the ultimate effect of the economy on environment.

GHGs are about Energy

C02 Emissions by Source



Nationally, electricity generation is responsible for 34 percent of all GHG emissions and 40 percent of all CO2 emissions.

Energy Policy Scenarios

To show how BEAR can support policy analysis, we offer preliminary results in three prominent areas:

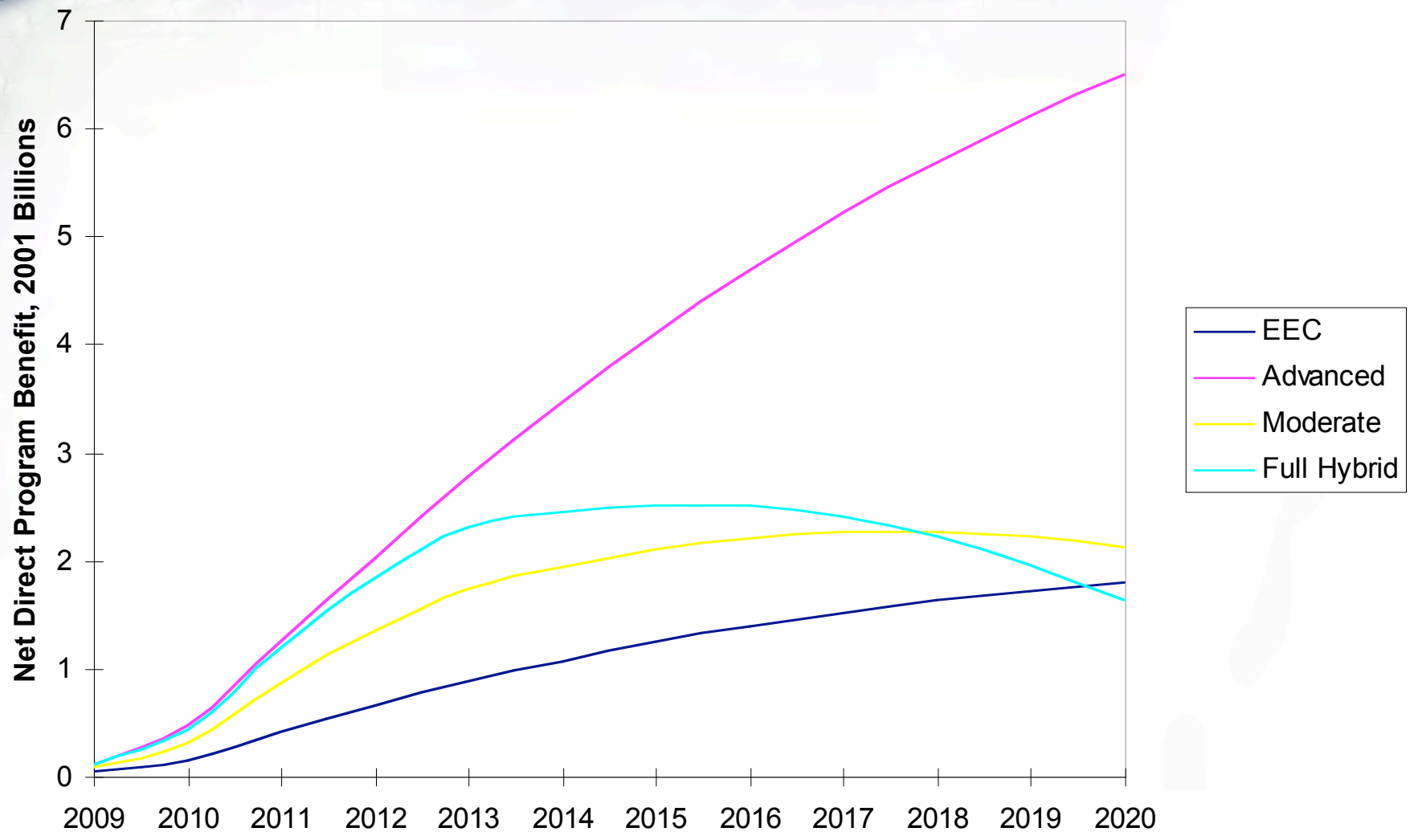
1. Pavley Vehicle Emissions Policy
2. Renewable Energy Portfolio
3. Carbon Cap/Tax and Trade

1. Pavley Vehicle Emissions Policy

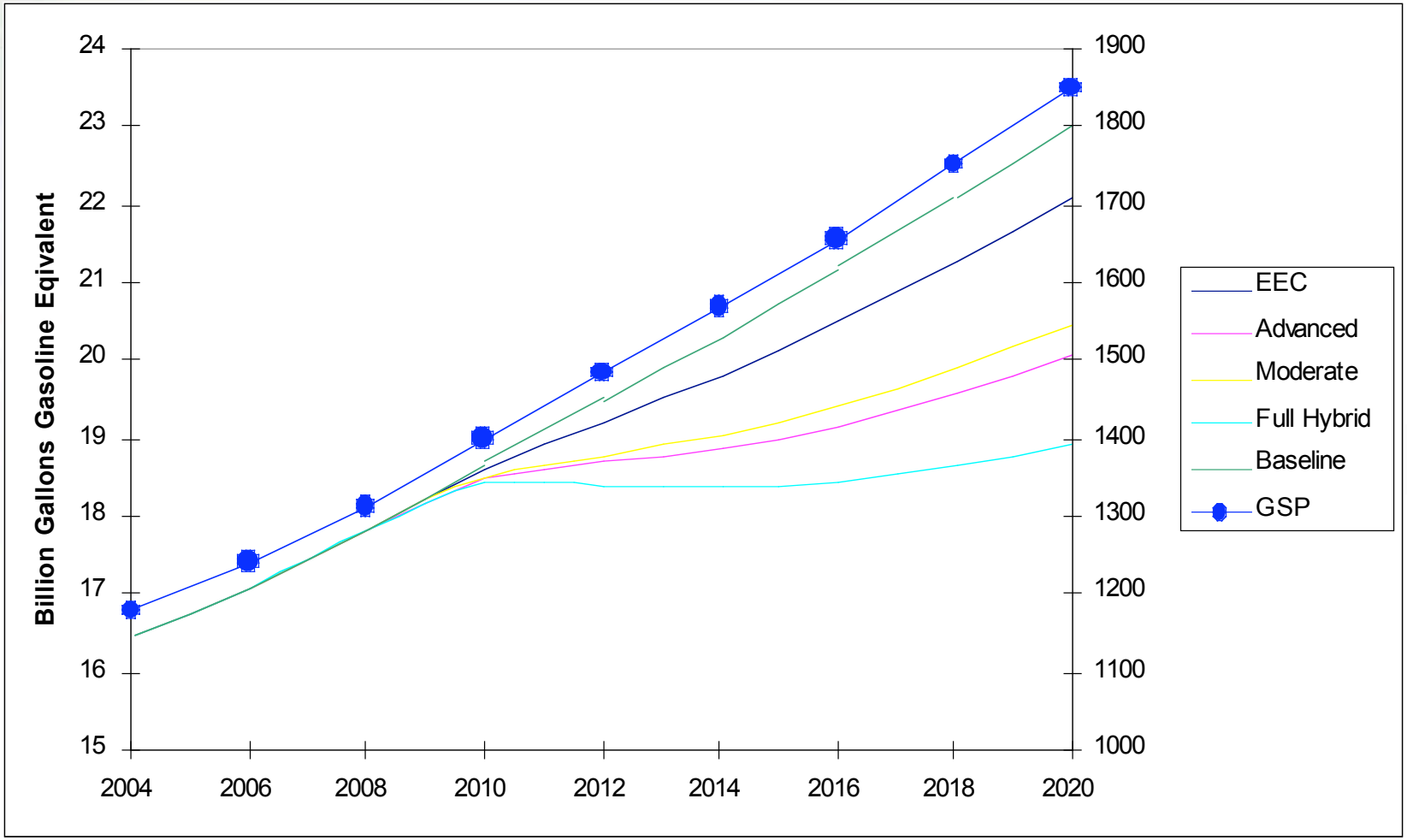
	Scenario	Direct Effects in 2020 (2001 Million $) Costs	Benefits
1	EEA LDV+GTL Blend	2,187	3,980
2	ACEEE Advanced+GTL Diesel Blend	4,824	11,322
3	ACEEE Moderate+GTL+Fuel Cell Veh	7,970	10,084
4	ACEEE Full Hybrid+GTL Blend	13,660	15,284

NB: Assumes $2/gal gasoline price.

Program Net Benefit-Cost



Impact: Efficiency with Growth



All Scenarios Increase GSP

Aggregate Results
(percent change from Baseline in 2020)

	EEC	Advanced	Moderate	Full Hybrid	
Real GSP	.26	.55	.92	1.50	Jobs
Employment	.06	.13	.15	.21	41,201
Consumption	.75	1.78	3.23	6.76	
Vehicle Fuel Use	-9.42	-20.85	-19.39	-24.95	
CO2 HH	-3.89	-12.41	-10.69	-17.19	
CO2 Ind	-1.86	-3.96	-3.74	-4.74	
CO2 Total	-2.51	-6.65	-5.95	-8.70	

GSP rises because consumption is re-directed to in-state demand. Personal consumption increases substantially.

Three Economic Principles

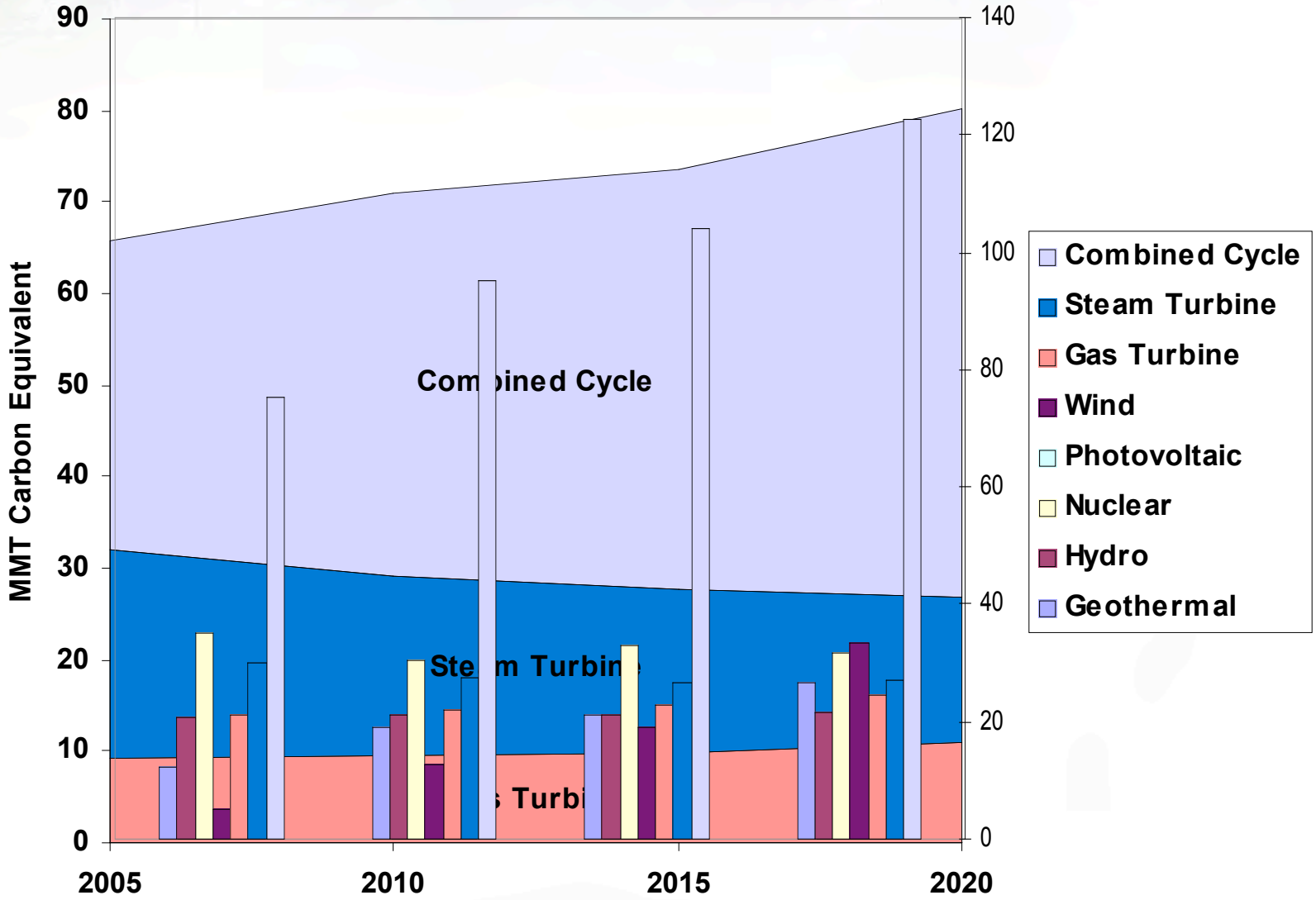
1. Adjustment cost: May appear high to stakeholders in the short term, but it is usually significantly outweighed by
2. Demand Stimulus: Long term savings lead to other spending.
3. Import Substitution: New demand is more likely to be for California goods and services.

2. Renewable Energy Portfolio

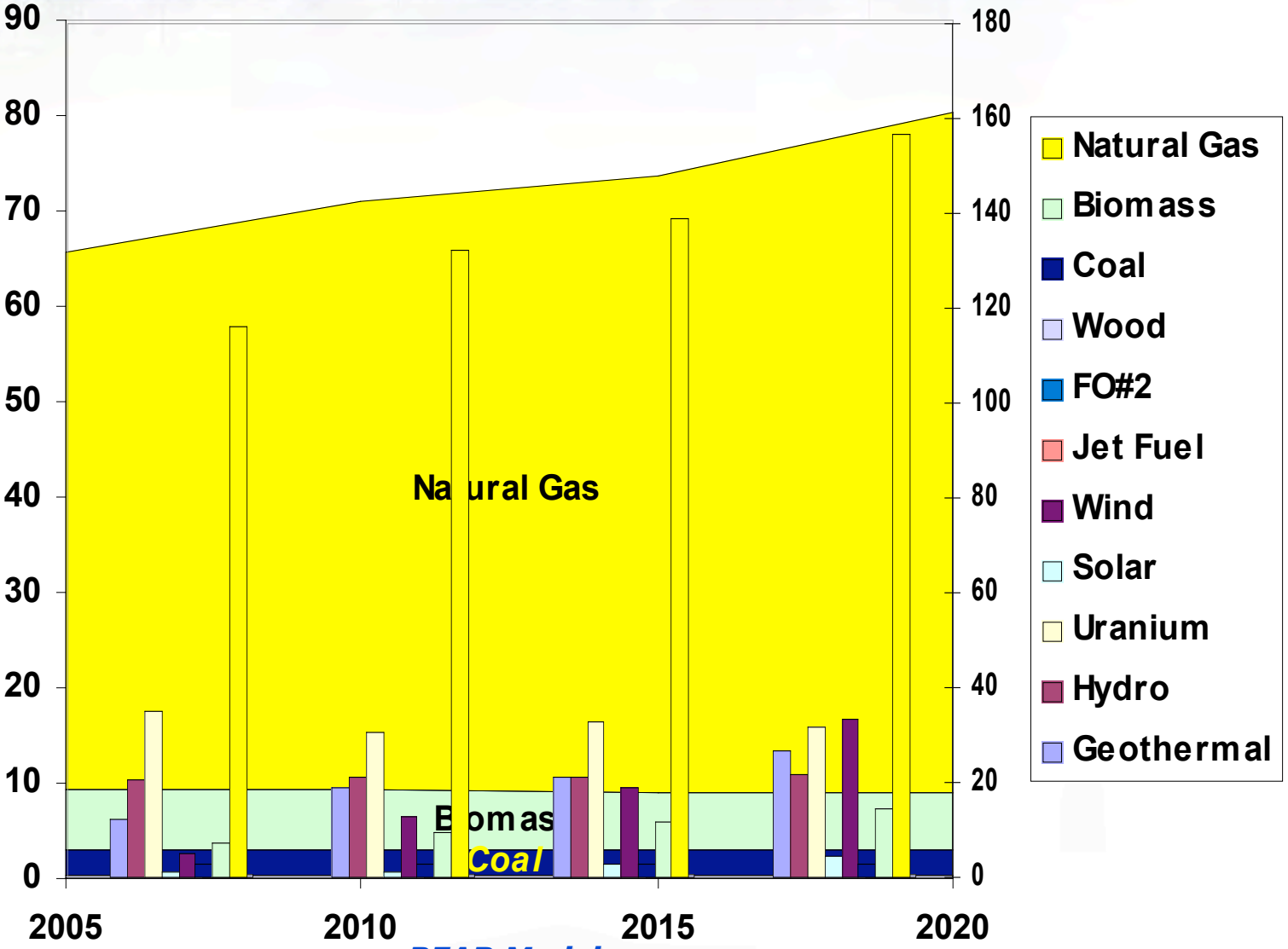
This research examines scenarios for increased use of renewable fuels in electricity generation.

We are currently studying market-based policies for voluntary adoption.

Baseline CO2 Emissions and Output by Generation Technology



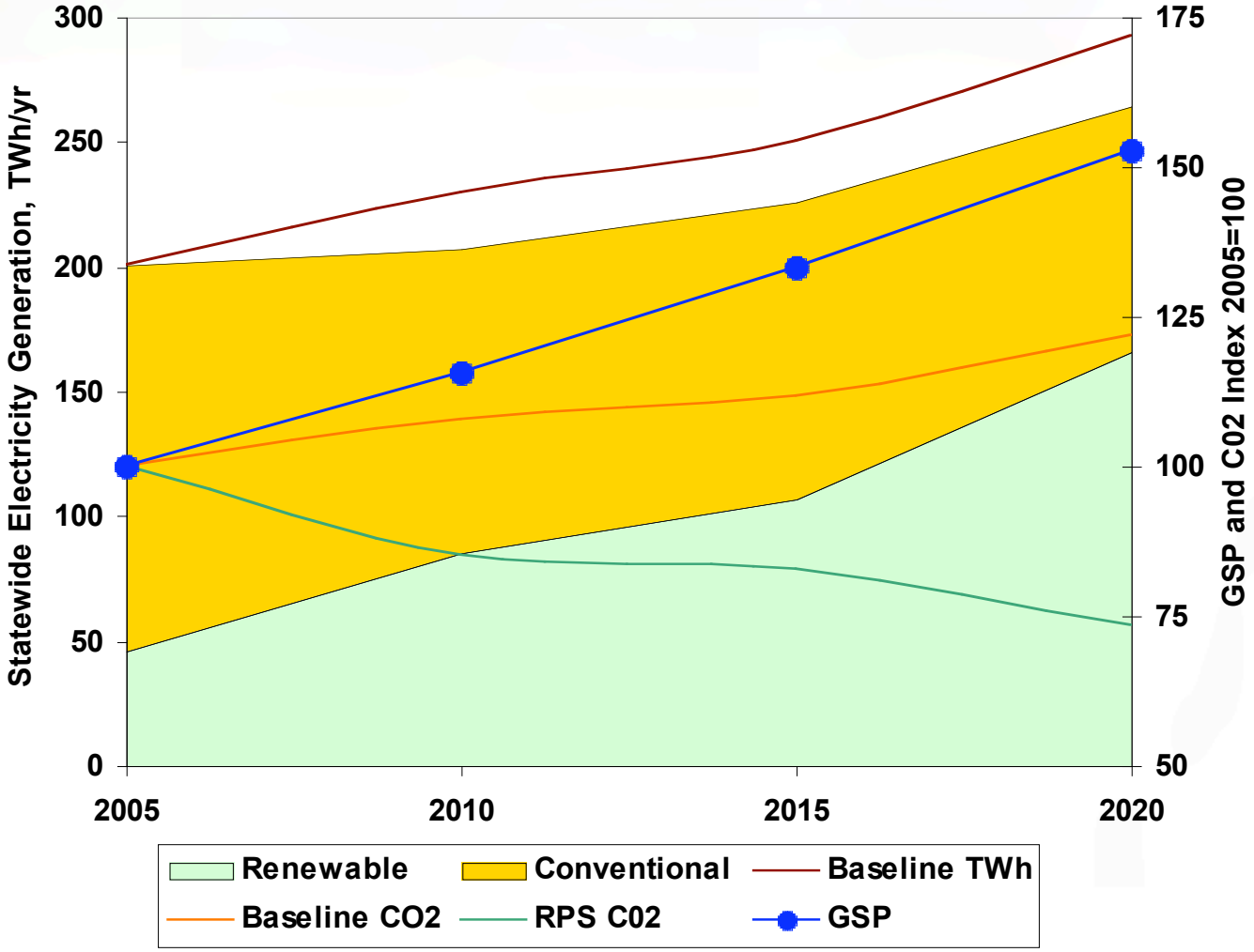
Baseline CO2 Emissions and Output by Fuel Type



Emissions and Output: Market-based Renewable Scenario

Assumptions:

- **Cost neutral initial subsidy**
- **Average Progress Ratio = 80%**
- **Decarbonization Rate = 2%**



3. Carbon Cap/Tax and Trade

We examine four scenarios:

1. CAP1 - 2000 emissions by 2010, Business as Usual (BAU) efficiency
2. CAP2 - 1990 emissions by 2020, BAU
3. CAP3 - CAP1 with historic (2.5%/yr) efficiency gains
4. CAP4 – CAP2 with learning-by-doing (4%/yr) efficiency gains

California's Goals are Attainable

Aggregate Results
(percent change from Baseline in 2020)

	CAP1	CAP2	CAP3	CAP4
Real GSP	-2.68	-6.44	-.01	.28
Employment	-4.88	-11.65	-.01	.52
Consumption	.77	4.46	.00	.09
Gov Exp	2.25	8.06	.00	-.06
CO2 HH	-46.17	-71.84	-29.05	-45.78
CO2 Ind	-20.99	-35.89	-28.98	-48.06
CO2 Total	-29.00	-47.33	-29.00	-47.33

Jobs
99,488

Other Ongoing BEAR Applications

- Non-C02 Gases – an important and less understood component of GHG
- Combined Heat and Power – Moderate gains in statewide efficiency, benefits outweigh costs
- Carbon sequestration – A complex portfolio choice among alternative storage media, but significant potential benefits
- Conservation – The biggest energy "resource," but technology adoption needs to be better understood

Conclusion: Innovation, Efficiency, and Growth

- California is the world's premiere innovation economy.
- Efficiency is a potent stimulus for demand growth.
- The Energy sector needs to join IT, Biotech, and other knowledge-intensive state industries to establish global standards for sustainable economic growth.